Attorney Docket No.: SHEL.110604/TH2478

CLAIMS

1. An apparatus for acoustically analyzing a fluid comprising:

a chamber for holding the fluid;

a transmitter positioned within the chamber for transmitting an acoustic signal

through the fluid;

a reflector moveably positioned within the fluid for reflecting the acoustic signal;

and

a receiver positioned within the chamber for detecting a reflection of the acoustic

signal.

2. The apparatus of Claim 1, wherein the chamber comprises a sealed first

end, a piston slidably disposed within a second end of the chamber and a conduit for

introducing the fluid into the chamber.

3. The apparatus of Claim 2, further comprising a servomotor for driving the

piston and varying at least one of a pressure and a temperature of the fluid within the

chamber.

4. The apparatus of Claim 1, wherein the chamber is thermally insulated to

substantially maintain at least one of a pressure and temperature of the fluid within the

chamber.

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- 5. The apparatus of Claim 1, wherein the transmitter and the receiver are embodied in a single piezoelectric transducer.
- 6. The apparatus of Claim 5, further comprising a static piston mounted within the chamber near the first end for supporting the transducer within the fluid.
- 7. The apparatus of Claim 6, further comprising a square-wave pulsar/receiver connected to the transducer for driving the transducer and processing the reflection of the acoustic signal.
- 8. The apparatus of Claim 7, further comprising an oscilloscope connected to the square-wave pulsar/receiver for imaging the reflection of the acoustic signal.
- 9. The apparatus of Claim 8, wherein the reflector is a disc positioned opposite the transducer relative to the piston.
- 10. The apparatus of Claim 8, wherein the reflector is a ring positioned opposite the transducer relative to the piston.
- 11. The apparatus of Claim 1, further comprising a first electromagnetic coil and a second electromagnetic coil, the first electromagnetic coil and the second electromagnetic coil being independently driven for manipulating the reflector.
- 12. The apparatus of Claim 11, wherein the reflector comprises at least one of a first reflective surface and a second reflective surface for analyzing a property of the fluid comprising at least one of velocity, volume, density, compressibility and viscosity.

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- 13. The apparatus of Claim 12, wherein the reflector comprises a material having a substantially low coefficient of thermal expansion and a high bulk modulus for mitigating any variation in a distance between the first reflective surface and the second reflective surface as the material is subjected to a predetermined temperature and pressure within the chamber.
 - 14. An apparatus for acoustically analyzing a fluid comprising:

a chamber for holding the fluid;

a transducer coupled with the chamber for transmitting an acoustic signal through the fluid and detecting a reflection of the acoustic signal; and

a reflector movably positioned within the fluid for reflecting the acoustic signal.

- 15. The apparatus of Claim 14, wherein the chamber comprises a sealed first end, a piston slidably disposed within a second end of the chamber and a conduit for introducing the fluid into the chamber.
- 16. The apparatus of Claim 14, further comprising a static piston mounted within the chamber near the first end for supporting the transducer within the fluid.
- 17. The apparatus of Claim 14, further comprising a first electromagnetic coil and a second electromagnetic coil, the first electromagnetic coil and second electromagnetic coil being independently driven for manipulating the reflector.

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- 18. The apparatus of Claim 17, wherein the reflector comprises at least one of a first reflective surface and a second reflective surface for analyzing a property of the fluid comprising at least one of velocity, volume, density, compressibility, and viscosity.
- 19. The apparatus of Claim 18, wherein the reflector comprises a material having a substantially low coefficient of thermal expansion and a high bulk modulus for mitigating any variation in a distance between the first reflective surface and the second reflective surface as the material is subjected to a predetermined temperature and pressure within the chamber.
- 20. A method for acoustically analyzing a fluid in a chamber using a transmitter, a substantially stationary reflector movably positioned within the fluid inside the chamber, and a receiver, the method comprising the steps of:

transmitting an acoustic signal from the transmitter through the fluid; and detecting reflections of the acoustic signal from the reflector at the receiver.

- 21. The method of Claim 20, wherein the transmitter and the receiver are embodied in a single piezoelectric transducer.
- 22. The method of Claim 21, wherein the transducer is supported within the fluid at one end of the chamber.
- 23. The method of Claim 22, wherein the reflector is a disc positioned opposite the transducer relative to another end of the chamber.

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- 24. The method of Claim 22, wherein the reflector is a ring positioned opposite the transducer relative to another end of the chamber.
- 25. The method of Claim 20, further comprising the step of determining a property of the fluid comprising at least one of velocity, volume, density, compressibility, and viscosity.
- 26. The method of Claim 25, wherein the velocity of the acoustic signal through the fluid at a predetermined temperature and pressure (Vel._{T,P}) is determined by:

$$Vel._{T,P} = D_{T,P} \div .5 \times (T_2 - T_1).$$

27. The method of Claim 26, wherein the volume of the fluid at a predetermined temperature and pressure (Vol._{T,P)} is determined by:

$$Vol._{T,P} = (.5 \text{ x } T_3 \text{ x } Vel._{T,P}) \text{ x } (\pi \text{ x } R^2).$$

28. The method of Claim 27, wherein the density of the fluid at a predetermined temperature and pressure (Den._{T,P}) is determined by:

$$Den_{T,P} = M \div Vol_{T,P}$$
.

- 29. The method of Claim 28, wherein the predetermined temperature is about 400° F and the predetermined pressure is about 25,000 psi.
- 30. The method of Claim 26, further comprising the step of calibrating the reflector based upon a known coefficient of thermal expansion for a material comprising the reflector.

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31. A method for acoustically analyzing a fluid in a chamber using a transducer and a substantially stationary reflector positioned within the fluid inside the chamber, the method comprising the steps of:

transmitting an acoustic signal from the transducer through the fluid; and detecting reflections of the acoustic signal from the reflector at the transducer.

- 32. The method of Claim 31, further comprising the step of determining a property of the fluid comprising at least one of velocity, volume, density, compressibility, and viscosity
- 33. A method for acoustically analyzing a fluid in a chamber using a transducer and a reflector moveably positioned within the fluid inside the chamber, the method comprising the steps of:

transmitting acoustic signals from the transducer through the fluid; and detecting reflections of the acoustic signals from the reflector at the transducer as the reflector moves.

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